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Pterional variable topography and morphology. An anatomical study and its clinical significance

K. Natsis[1], I. Antonopoulos[2], C. Politis[3, 4], E. Nikolopoulou[2], N. Lazaridis[1], G.P. Skandalakis[2], D. Chytas[5], M. Piagkou[2]

[1]*Department of Anatomy and Surgical Anatomy, School of Medicine, Faculty of Health Sciences, Aristotle University of Thessaloniki, Greece*
[2]*Department of Anatomy, School of Medicine, Faculty of Health Sciences, National and Kapodistrian University of Athens, Greece*
[3]*OMFS-IMPATH Research Group, Department of Imaging and Pathology, Faculty of Medicine, Katholieke Universiteit Leuven, Belgium*
[4]*Department of Oral and Maxillofacial Surgery, University Hospitals Leuven, Belgium*
[5]*School of Medicine, European University of Cyprus, Engomi, Nicosia, Cyprus*

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Background: *Pterion is the junction of the frontal, parietal, greater wing of the sphenoid and the squamous part of the temporal bone. The sphenoparietal, frontotemporal, stellate and epipteric pteria were described. The current study determines pterion topography, morphology (variant types' frequency) and morphometry, as well as epipteric bones presence in dried skulls. Gender impact is underlined as well.*

Materials and methods: *Ninety Greek adult dried skulls were observed. The distances in between pterion and the zygomatic arch midpoint and in between pterion and the frontozygomatic suture were measured.*

Results: *The sphenoparietal pterion was the commonest (58.3%), following by the stellate (25%), epipteric (15.5%) and by the frontotemporal pterion (1.1%). Twenty-eight (15.5%) skulls had epipteric bones, further categorised as quadrisutural (35.7%), trisutural (57.1%), bisutural and multiple (3.57%). The mean distances between pterion and the midpoint of zygomatic arch were 4.13 ± 0.45 cm on the right and 4.09 ± 0.47 cm on the left side and between pterion and the frontozygomatic suture were 3.47 ± 0.61 cm on the right and 3.52 ± 0.65 cm on the left side. Both distances were symmetrical. Male skulls showed slightly higher values on the left side for the distance (pterion–midpoint of zygomatic arch).*

Conclusions: *Pterion is a commonly used neurosurgical landmark and thus in depth knowledge of the pteric area and its variants could be valuable. Recognition of the possible variability in pterion location, morphology and morphometry, as well as possible occurrence of epipteric bones may render pterional craniotomy safer among different population groups.* (Folia Morphol 2021; 80, 4: 994–1004)

Key words: pterion, skull, zygomatic arch, frontozygomatic suture, epipteric bone, variation, anatomy

Address for correspondence: Assoc. Prof. M. Piagkou, DDS, MD, MSc, PhD, Department of Anatomy, School of Medicine, Faculty of Health Sciences, National and Kapodistrian University of Athens, M. Asias 75, Street, 11527 Greece, tel: +30 210 7462427, fax: +30 210 7462398, Mob: +306984316353, e-mail: mapian@med.uoa.gr; piagkoumara@gmail.com

INTRODUCTION

Pterion, an H-shaped small circular area, is a point of convergence of the frontal (F), sphenoid (S), parietal (P), and squamous part of the temporal bone (T) (articulation of the coronal, sphenoparietal, squamosal, sphenofrontal and sphenosquamosal sutures) [36, 56]. It corresponds to the site of the anterolateral (sphenoidal) fontanelle which disappears approximately 3 months after birth [50]. Although the sutures contributing to pterion, exhibit a wide variability [11], their relationships are not yet elucidated. Variant sutural patterns in pterional area are the outcome of combination of various environmental and epigenetic factors [7, 55].

From the morphometric point of view, as the classical anatomical textbooks refer, the pterion is located approximately 3.0–3.5 cm behind the frontozygomatic suture (FZMS) and 4.0 cm above the midpoint of the zygomatic arch (MPZ) forming the temporal fossa floor [36, 50].

Pterion is a reference cranial landmark for the anterior branch of the middle meningeal artery, the Broca's motor speech area, the insula, the stem of lateral sulcus and the anterior cisterns of the encephalon base [14, 16, 23, 40]. In addition, age and gender determination in forensic and archaeological cases could be based on pterion [29].

Although suboptimal pterion localisation may compromise surgical access and therefore treatment outcome, studies focusing on pterion morphology and surgical anatomy are scarce. Knowledge of pterion location, presence and distribution of sutural bones convergence, the so-called epipteric bones (EBs), as well as different types of classified pteria are important to prevent complications when drilling burr pterional holes [24, 46]. In such cases, (i.e. in a penetrating orbital injury) surgery should be minimally invasive, while gaining access to the sphenoid ridge and optic canal [59].

The current study underlines morphological variability of the bones forming pterional area, taking into consideration variant distribution of EBs, their frequency and relationship with pterion sutures. A terminology of the EBs is proposed. Exact pterion location in relation to FZMS and MPZ was also recorded. Both morphological and morphometric observations were analysed taking into account laterality, gender and age as well.

MATERIALS AND METHODS

Ninety (49 male and 41 female) Greek adult dried skulls from the osseous collections of the Department of Anatomy and Surgical Anatomy of the Aristotle University and the Department of Anatomy of the National and Kapodistrian University were investigated on the right (R) and left (L) sides (180 sides). Exclusion criteria included children skulls, unknown gender and age skulls, damaged and deformed skulls and skulls with pathology and trauma affecting measurement landmarks. Thus, 180 (98 male and 82 female) pteria were subdivided in three age groups: 20–39 years (46 pteria), 40–59 years (40 pteria), over 60 years of age (94 pteria) to examine age effect in pterion topography, morphology and morphometry. All skulls were derived from body donation, before death, after written informed consent.

Pterion morphology. Various pteria frequencies were recorded and all pteria were classified into four types, based on Murphy's classification [37]. Sphenoparietal (SP), frontotemporal (FT), stellate (St) and epipteric (E) pteria appear in Figure 1A, B, C, and D, respectively. A circle was drawn to locate the adjacent bones forming pterion area.

Epipteric bones number and distribution. Skulls with E pterion (EBs) were further classified having as a guide the number of sutures converging to the EB. A novel epipteric terminology, based on the number and name (frontal — F, parietal — P, temporal — T, and sphenoidal — S) of sutures articulating with EB, is proposed:

- single EB articulating with 4 sutures (FPTS) (a typical quadrisutural EB) (Fig. 2A);
- a single EB articulating with 3 sutures (trisutural EB) was further subclassified as superior (FPT) (Fig. 3A), inferior (FTS) (Fig. 3B), anterior (FPS) (Fig. 3C), and posterior (PTS) (Fig. 3D);
- an EB articulating with two sutures (PS or ST) (bisutural EB) (Fig. 2B);
- several EBs or multiple (in the form of multiple fragments) (Fig. 2C).

Pterion morphometry. Two distances, in between pterion centre and MPZ and pterion centre and FZMS were bilaterally measured using a digital calliper (Mitutoyo, ABSOLUTE 500-196-20 Digital Calliper, 0.001 mm accuracy) (Fig. 4). The study was conducted in accordance to the Ethical Committee standards and with the 1964 Helsinki declaration and its later amendments. Measurements' reliability was assessed by examining the interobserver and intraobserver reliabilities using interclass and intraclass correlation coefficient. The intraclass correlation coefficient (ICC) was interpreted as poor if it

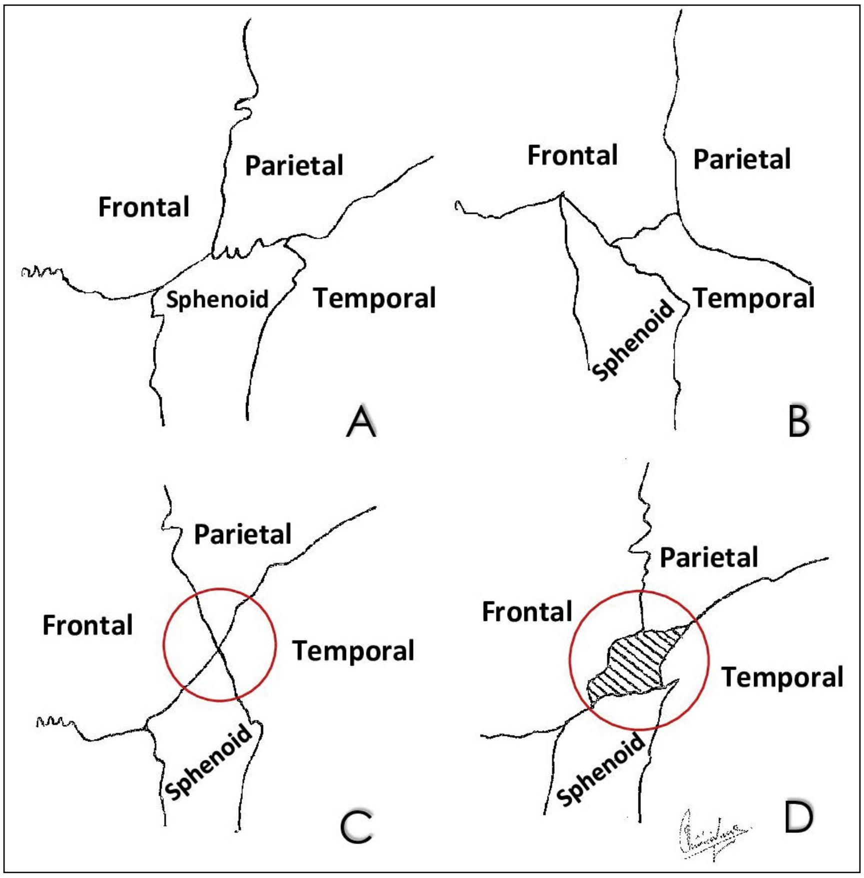

Figure 1. The frequency of various types of pterion based on Murphy's classification as modified accordingly, sphenoparietal (**A**), frontotemporal (**B**), stellate (**C**), and epipteric (**D**).

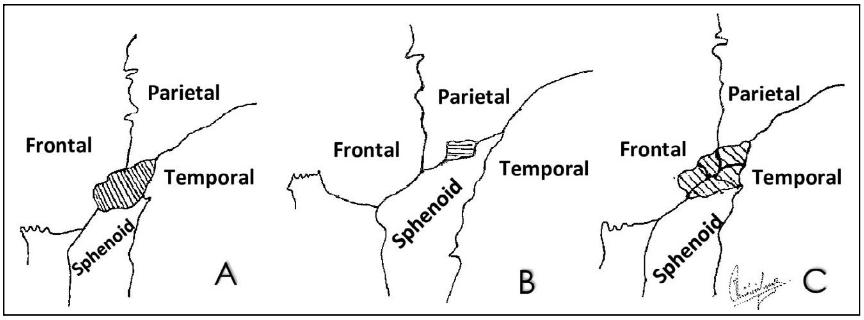

Figure 2. Classification of epipteric bones as quadrisutural (**A**), bisutural (**B**) and multiple (**C**).

was less than 0.4; as marginal when it was between 0.4 and 0.75; and as good when it was greater than 0.75. Descriptive statistics were evaluated for pterion morphometric measurements and their statistical distribution was analysed. Data normality was evaluated with Kolmogorov-Smirnov test. Wilcoxon signed ranks test was applied to investigate side asymmetry, Mann-Whitney U test and t test for gender dimorphism, and Kruskal-Wallis and one-way ANOVA tests to evaluate correlation with age. For all analyses, p value < 0.05 was considered statistically significant. Statistical analysis was carried out using IBM SPSS Statistics for Windows, version 21.0.

RESULTS

Pterion morphology. All pteria types (SP, FT, St and E) were identified (Fig. 5). SP pterion was the predominant type (58.3%, 105 skulls), St the second most common (25%, 45 skulls) following by the E (15.5%, 28 skulls) and the FT type (1.1%, 2 skulls on the R). Pterional symmetry was detected (57 skulls,

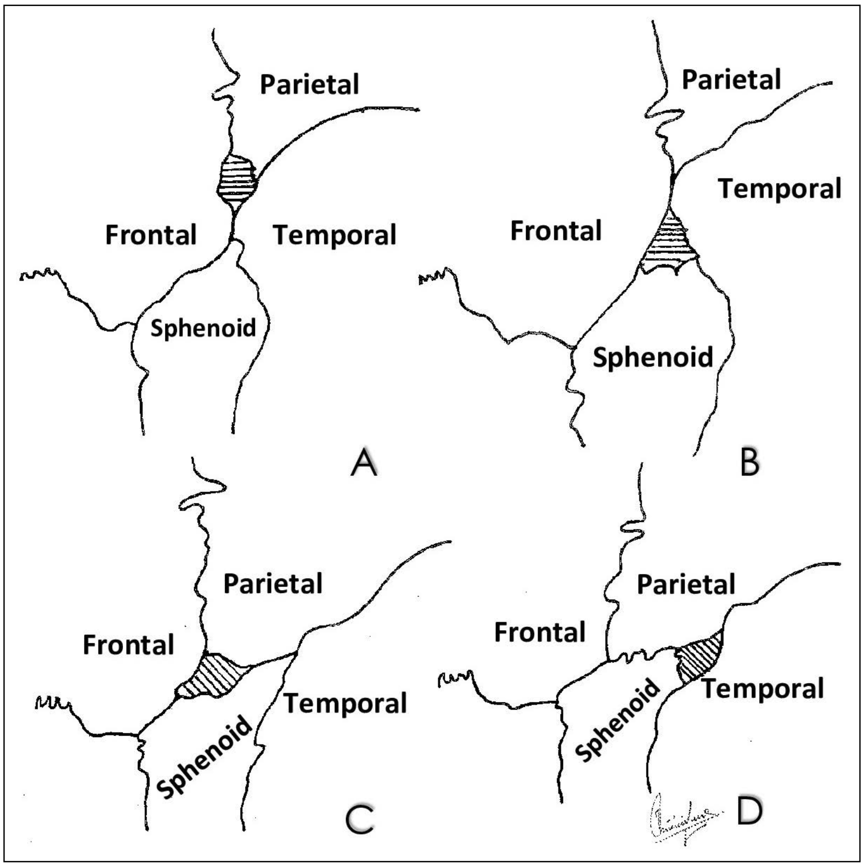

Figure 3. Classification of the trisutural epipteric bones observed according to their location as superior (**A**), inferior (**B**), anterior (**C**) and posterior (**D**).

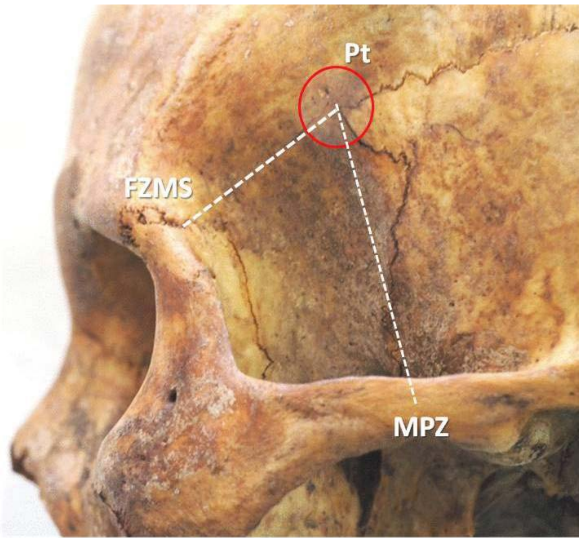

Figure 4. Distances from the pterion (Pt) centre to the midpoint of zygoma (MPZ) and from the Pt centre to the frontozygomatic suture (FZMS).

63.3%) (SP in 43, St in 10 and E in 4 skulls). In asymmetrically pairing skulls, the commonest pterion types were the SP-St (16.7%, 15 skulls) and the SP-E (12 skulls). Age and gender had no significant impact on pterion type (Table 1).

Epipteric bone morphology. Twenty-eight (15.5%) skulls with EBs were further classified as quadrisutural (FPTS) (Fig. 6A) (35.7%, 10 skulls, 1 skull bilaterally and 9 skulls unilaterally — 5L and 4R), trisutural (Fig. 6B) (57.1%, 16 skulls unilaterally — 11L and 5R), bisutural (3.57%, 1 skull on the L) (Fig. 6C) and multiple EBs (3.57%, 1 skull on the L) (Fig. 6D).

Pterion morphometry. The mean distances (pterion-MPZ) and (pterion-FZMS) were symmetrical (R: 4.13 ± 0.45 cm, L: 4.09 ± 0.47 cm) and (R: 3.47 ± ± 0.61 cm, L: 3.52 ± 0.65 cm). No gender dimorphism was detected for all measured distances, except for the mean distance (pterion-FZMS) on the L (males 3.65 ± 0.72 vs. females 3.37 ± 0.51 cm, $p = 0.039$) (Table 2). No statistically significant difference was detected for both measurements among different age groups (Table 3). ICC for the interobserver and intraobserver reliabilities was 0.892 and 0.901 for pterion-MPZR, 0.879 and 0.845 for pterion-MPZL, 0.908 and 0.897 for pterion-FZMSR and 0.867 and 0.856 for pterion-FZMSL, respectively.

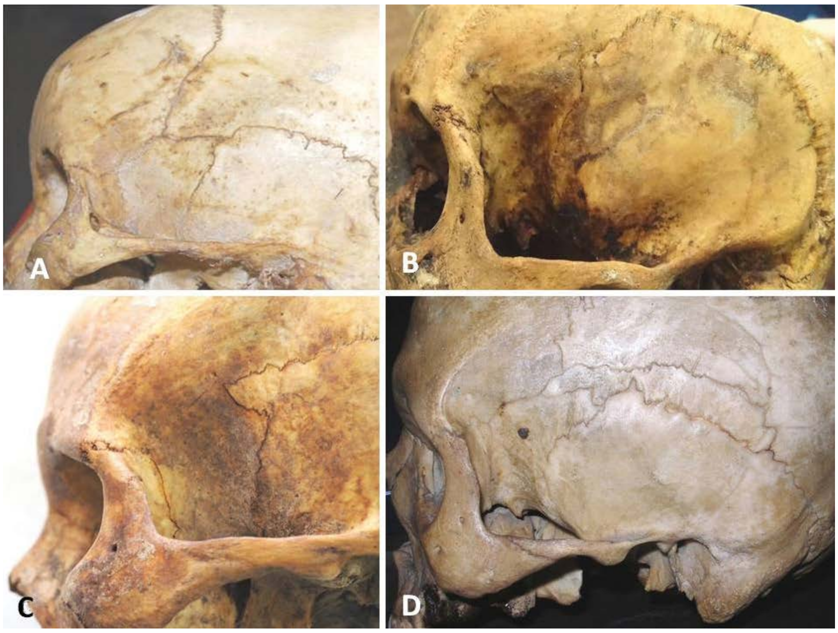

Figure 5. Depiction of various pterion types in Greek skulls, sphenoparietal (**A**), frontotemporal (**B**), stellate (**C**), and epipteric (**D**).

Table 1. Pterion types' frequency observed on the right (R) and left (L) sides of the skulls, combination types on asymmetrical skulls, gender (M — males, F — females) and age impact

Independent variables	Pterion types								
Laterality	**Sphenoparietal type (SP)**		**Frontotemporal type (FT)**		**Epipteric type (E)**		**Stellate type (S)**		
Right side (R)	50 (55.5%)		2 (2.2%)		11 (12.2%)		27 (30%)		
Left side (L)	55 (61.1%)		—		17 (18.9%)		18 (20%)		
Total	105 (58.3%)		2 (1.1%)		28 (15.5%)		45 (25%)		
Combination types of pterion									
SP-SP	**SP-S**		**SP-E**		**S-S**		**E-E, SP-FT**		**E-S**
43 (47.8%)	15 (16.7%)		12 (13.3%)		10 (11.1%)		4 (4.44%)		2 (2.22%)
Gender	**Type SP**		**Type FT**		**Type E**		**Type S**		**P**
	R	**L**	**R**	**L**	**R**	**L**	**R**	**L**	
Males	30 (61.2%)	31 (63.26%)	1 (2.04%)	—	2 (4.08%)	10 (20.4%)	16 (32.65%)	8 (16.32%)	0.187, 0.829
Females	20 (48.78%)	24 (58.53%)	1 (2.43%)	—	9 (21.95%)	7 (17.07%)	11 (26.82%)	10 (24.39%)	
Total	61 sides in M, 44 sides in F		1 side in M, 1 side in F		12 sides in M, 16 sides in F		24 sides in M, 21 sides in F		

DISCUSSION

Pterion morphology. Pterion variable morphology is classified into SP, FT, St and E types and has been extensively studied among different populations (Table 4). In depth knowledge of pterion type and location could be an extremely useful tool in neurosurgical procedures, skull identification and forensics. Yasargil et al. (1975) [58] first introduced the pterional approach and its extension. Pterional approach achieves more accurate and safer outcomes for sellar or suprasellar lesions, brain arterial circulation and lateral sulcus, as well as for aneurysms of the distal internal carotid artery, as the conventional craniotomy was replaced from mini-craniotomy and to contemporary keyhole surgery [12].

Although classical anatomical textbooks describe St pterion as the typical pattern, this pterion was found with a frequency of 25% in the current study, while the predominant pterion was the SP (58.3%), similarly to all the other studies summarized in Table 4. In Asians, the SP pterion frequency ranged between 71.7% and 93.55% and among them Indians have the highest fre-

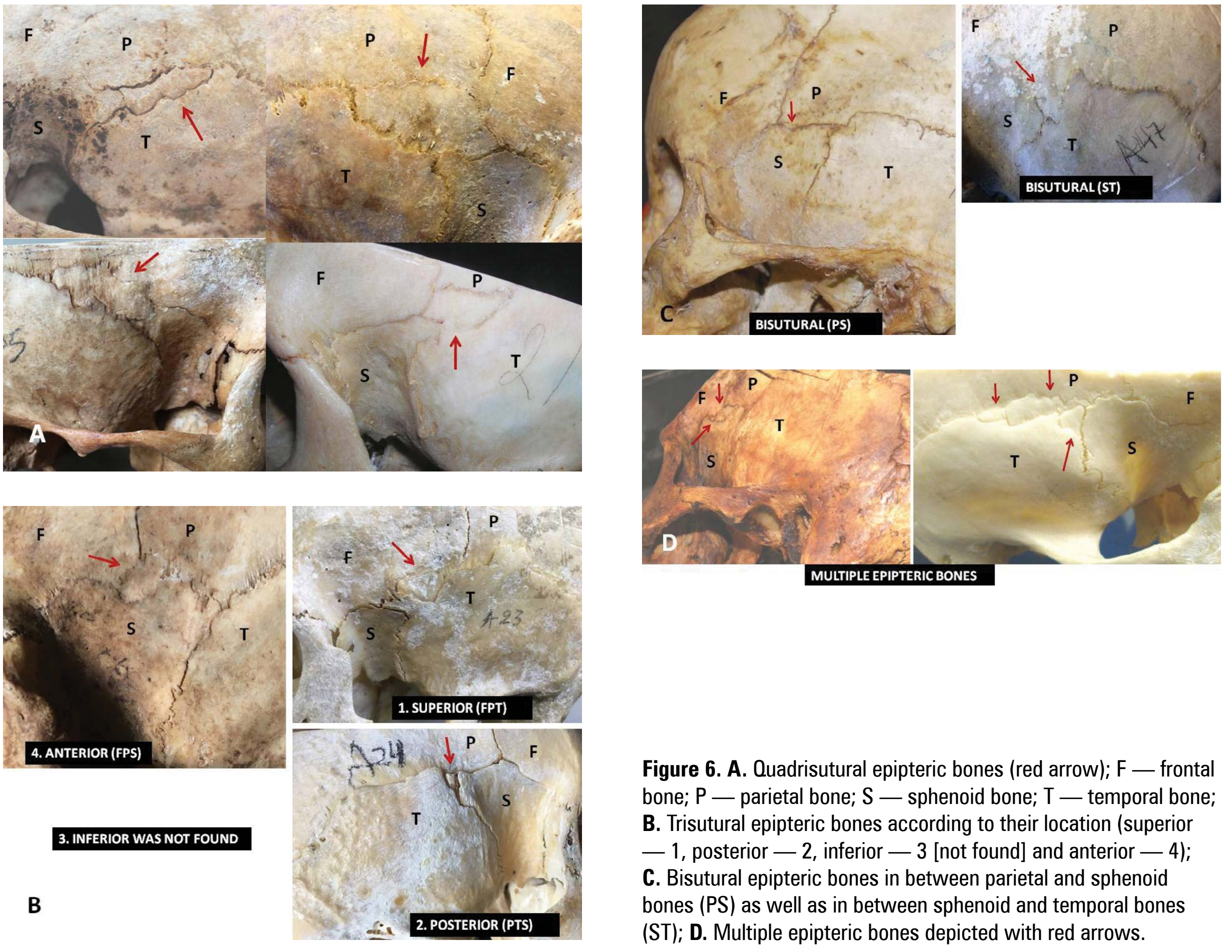

Figure 6. A. Quadrisutural epipteric bones (red arrow); F — frontal bone; P — parietal bone; S — sphenoid bone; T — temporal bone; **B.** Trisutural epipteric bones according to their location (superior — 1, posterior — 2, inferior — 3 [not found] and anterior — 4); **C.** Bisutural epipteric bones in between parietal and sphenoid bones (PS) as well as in between sphenoid and temporal bones (ST); **D.** Multiple epipteric bones depicted with red arrows.

Table 2. Mean ± standard deviation (SD), minimum and maximum distances of pterion (Pt) to the midpoint of zygoma (MPZ) and to the frontozygomatic suture (FZMS) [cm] on the right (R) and left (L) sides of the skulls, male and female incidence

Values	Distances according to side				Distances according to gender							
					Males		Females		Males		Females	
	Pt-MPZ R	Pt-MPZ L	Pt-FZMS R	Pt-FZMS L	Pt-MPZ R	Pt-MPZ L	Pt-MPZ R	Pt-MPZ L	Pt-FZMS R	Pt-FZMS L	Pt-FZMS R	Pt-FZMS L
Mean ± SD	4.13 ± 0.45	4.1 ± 0.47	3.47 ± 0.61	3.52 ± 0.65	4.19 ± 0.44	4.12 ± 0.55	4.04 ± 0.46	4.07 ± 0.42	3.51 ± 0.62	3.65 ± 0.73	3.43 ± 0.59	3.37 ± 0.51
Minimum	2.87	3.11	2.0	1.73	3.29	3.11	2.87	3.16	2.09	1.73	2.0	2.48
Maximum	5.32	5.7	4.81	5.2	5.32	5.7	5.2	5.1	4.63	5.2	4.81	4.78
P	p = 0.608 (symmetry)		p = 0.471 (symmetry)		p = 0.133 right ANOVA, p = 0.619 left ANOVA				p = 0.517 right ANOVA, p = 0.039 left (gender dimorphism)			

quencies (69.25–93.5%) (Southern [80–93.55%] and Western Indians [91.7%] showed higher frequencies compared to Northern [71.7–89.2%]), while Koreans have the lowest (76.5%) [26]. Kenyans had the lowest reported frequency (66%) [38]. The high frequency of SP pterion could be a result of evolution [28], given that it is the commonest type in primates [8, 47].

The second commonest pterion type is the FT [54], with a varying incidence among different populations: Nigerians (10.1% and 23.6%) [46], Northern Indians (10%) [62], Turkish (10%) [40] and Kenyans 15% [38]. In the current study, the frequency of FT pterion was significantly lower (2.2% on the R), whereas no skull was found with a FT pterion on the L. However, the frequency is similar to those of Indian (Western [31] and Southern [36]) populations. In the present study, St pterion was the second most common type on the R (30%) and L (20%). The frequency of the E type of

Table 3. Mean values standard deviation (SD), minimum and maximum distances (in cm) from the pterion to the midpoint of zygoma (MPZ) and to the frontozygomatic suture (FZMS) on the right (R) and left (L) sides of the skulls among the three age groups

N	Age groups [years]											
	20–39				40–59				Over 60			
	MPZ R	MPZ L	FZMS R	FZMS L	MPZ R	MPZ L	FZMS R	FZMS L	MPZ R	MPZ L	FZMS R	FZMS L
Mean ± SD	4.15 ± 0.43	4.12 ± 0.44	3.40 ± 0.7	3.37 ± 0.75	4.1 ± 0.45	4.1 ± 0.5	3.38 ± 0.66	3.46 ± 0.71	4.13 ± 0.48	4.1 ± 0.48	3.54 ± 0.53	3.62 ± 0.56
Minimum	3.51	3.44	2.0	2.25	3.29	3.11	2.09	1.73	2.87	3.16	2.3	2.4
Maximum	5.2	5.1	4.81	4.69	4.73	4.93	4.32	4.90	5.32	5.70	4.40	5.2
P	p = 0.916 right MPZ, p = 0.522 right FZMS, p = 0.962 left MPZ and p = 0.319 left FZMS											

Table 4. Comparative review of pterion types in different populations among several studies, arranged in order by year of publication

Author(s)	Year	Population	Sample N = skulls (sides)	Type of pterion			
				Sphenoparietal (%)	Frontotemporal (%)	Stellate (%)	Epipteric (%)
Murphy [37]	1956	Australian	368	73.2	7.7	0.7	18.4
Agarwal et al. [2]	1980	North Indian	450 (900 sides)	71.7	3.3	1.7	23.3
Saxena et al. [47]	1988	Indian	72 (144)	82.6	2.8	1.4	13.2
Saxena et al. [47]	1988	Nigerian	40 (80)	81.2	11.3	5.0	2.5
Manjunath and Thomas [31]	1988	South Indian	172	93.5	3.5	2.9	17.3
Matsumura et al. [32]	1991	Japanese	614	82.4	2.9	0.7	14.0
Asala and Mbajiorgu [7]	1996	Nigerian	212	82.1	23.6	—	5.7
Lee et al. [26]	2001	Korean	149	76.5	—	—	40.3
Saxena et al. [46]	2003	North Indian	203	87.7	10.0	5.17	—
Ersoy et al. [14]	2003	Turkish	300 (490 sides)	96.0	3.8	0.2	9.0
Oguz et al. [40]	2004	Turkish	26 (52)	88.0	10.0	—	2.0
Mwachaka et al. [38]	2009	Kenyan	50	66.0	15.0	7.0	12.0
Ilknur et al. [22]	2009	Anatolian	28	89.2	3.6	3.6	3.6
Zalawadia et al. [62]	2009	West. Indian	42	91.7	2.4	1.2	4.7
Hussain Saheb et al. [20]	2010	Indian	125	69.25	17.35	9.7	3.7
Apinhasmit et al. [6]	2011	Thais	268 (536)	81.2	1.1	0.4	17.3
Natekar et al. [39]	2011	Indian	150 bones	85.3	8.0	10.6	51.4
Ma et al. [30]	2012	Australian	76	78.4	5.2	—	16.4
Praba and Venkatramaniah [41]	2012	Indian	50	74.0	3	9.0	14.0
Ukoha et al. [53]	2012	Nigerian	56	75.3	19.5	1.7	3.6
Adejuwon et al. [1]	2013	Nigerian	62	86.1	8.3	5.6	—
Kumar et al. [25]	2013	Indian	40	86.25	11.25	2.5	—
Sudha et al. [51]	2013	South Indian	150	80.0	3.0	5.3	11.3
Aksu et al. [3]	2014	Anatolian	128	85.2	1.1	5.5	8.2
Eboh and Obaroefe [13]	2014	Nigerian	50	83.0	5.0	6.0	6.0
Prasad et al. [42]	2015	North Indian	60	89.2	3.3	5.0	2.5
Modasiya and Kanani [35]	2018	North Indian	220	81	—	10.9	8.1
Present study	2019	Greek	90	58.4	1.1	25	15.5

Table 5. Comparative review of pterion (Pt) distances from the frontozygomatic suture (FZMS) and the midpoint of zygoma (MPZ) among different populations in several studies, in order by year of publication (in cm)

Author(s)	Year	Population	Sample N = skulls (sides)	Distances			
				Pt-FZMS R	Pt-FZMS L	Pt-MPZ R	Pt-MPZ L
Oguz et al. [40]	2004	Turkish male	26 (52)	3.3 ± 0.39	3.44 ± 0.40	4.05 ± 0.39	3.85 ± 0.25
Ilknur et al. [22]	2009	Anatolian	28	3.5 ± 0.5	3.5 ± 0.5	3.8 ± 0.4	3.9 ± 0.4
Mwachaka et al. [38]	2009	Kenyan	50	3.03 ± 0.34*	3.03 ± 0.43*	3.88 ± 0.35*	3.82 ± 0.35*
Bhargavi et al. [10]	2011	Indian	70	3.93 ± 0.37	3.8 ± 0.40	4.52 ± 0.32	4.45 ± 0.35
Ma et al. [30]	2012	Australian	76	2.6 ± 4.0	2.5 ± 4.0	3.4 ± 4.0	3.4 ± 4.0
Ukoha et al. [53]	2012	Nigerian	56	2.74 ± 0.07	2.74 ± 0.06	4.02 ± 0.05	4.01 ± 0.03
Adejuwon et al. [1]	2013	Nigerian	62	3.15 ± 0.67*	3.08 ± 0.80*	3.91 ± 0.58*	3.87 ± 0.63*
Aksu et al. [3]	2014	Anatolian	128	3.18 ± 0.45*	3.14 ± 0.47*	4.0 ± 0.40*	3.98 ± 0.40*
Eboh and Obavoefe [13]	2014	Nigerian	50	3.21 ± 0.26*	3.11 ± 0.22*	4.02 ± 0.29*	3.95 ± 0.33*
Present study	2019	Greek	90	3.47 ± 0.61*	3.52 ± 0.65*	4.13 ± 0.45*	4.09 ± 0.47*

*Studies with modified measurements into [cm] from [mm]; L — left; R — right

Pt is similar to that reported in Indians (11.8%) [8] and Kenyans (12%) [38].

Epipteric bone morphology. Ranke (1898) [43] proposed the most suitable hypothesis concerning the EBs occurrence. He supported that an EB appears in case of fusion failure of the postero-superior border of the greater sphenoidal wing (via its separate ossification centre) with the rest part of the greater wing, during the 4th month of the intrauterine life. The EBs occurrence and laterality is variable among different populations, as the result of genetic and epigenetic factors combination [9, 34, 45]. In the current study, among the 28 skulls with EBs (31.1%), trisutural EBs were found in 16 skulls (17.7%), quadrisutural in 10 skulls (11.1%), bisutural and multiple EBs in a single skull (1.11%) per each, on the L. Among Indian populations, a wide range of EBs frequency was reported ranging between 2.5% to 24% in Northern [42] and Karnataka Indians [5]. Saxena et al. (2003) [46] found the lowest frequency of EBs in Nigerians (3.79%), contrariwise to the present study reporting the highest frequency of 31.1%. Neurosurgeons should be aware of EBs occurrence and variant distribution, since their presence when making burr holes over the pterional area may lead to complications.

In such cases caution must be made, as the most anterior point of junction of four bones may be mistaken to be the pterion centre resulting in orbital penetration. High index of suspicion is required from both radiologists and neurosurgeons, since in pterional trauma the EBs may be mistaken as a skull fracture in X-rays [9, 62].

Pterion morphometry. The mean distances (pterion-MPZ) and (pterion-FZMS) in different populations are summarized in Table 5. In the present study, the mean (pterion-MPZ) distance was 4.13 ± 0.45 cm on the R and 4.09 ± 0.49 cm on the L, similarly to Nigerian (4.02 ± 0.05 cm on the R and 4.01 ± 0.03 cm on the L) [53] and Turkish population (4.05 ± 0.39 cm on the R and 3.85 ± 0.25 cm on the L) [40] (4.0 ± ± 0.40 cm on the R and 3.98 ± 0.40 cm on the L) [3]. A lower mean distance has been reported in Australian (3.4 ± 4.0 cm) [30] and Anatolian (3.8 ± 0.4 cm) populations [22]. However, a higher mean distance has been reported in Indians (4.52 ± 0.32 cm on the R and 4.45 ± 0.35 cm on the L) [10].

In the present study, the pterion was detected behind FZMS up to 3.51 cm in males and up to 3.39 cm in females. This slight difference may be explained by the larger male skulls. The mean distance (pterion-FZMS) was 3.47 ± 0.61 cm on the R and 3.52 ± ± 0.65 cm on the L. The highest mean values were reported in Indians [10] (3.93 ± 0.37 cm on the R and 3.80 ± 0.40 cm on the L) and the lowest in Australians (2.6 ± 4.0 cm on the R and 2.5 ± 4.0 cm on the L) [30] and Nigerians (2.74 ± 0.07 cm on the R and 2.74 ± ± 0.06 cm on the L) [53]. Since significant differences were observed for pterion-MPZ and pterion-FZMS distances among various studies' populations, the pterion topography may vary due to epigenetic, environmental factors and evolution [10, 21, 44].

Pterion could be safely used as a surface landmark in neurosurgical approaches and interventions [40], even in neonates [14]. Its clinical importance derives from the fact that it overlies the anterior (frontal) branch of the middle meningeal artery, which is the most frequent source of acute traumatic epidural haematoma [30]. The knowledge of pterional typical anatomy, as well as its variants is important to neurosurgeons during pterional craniotomy [18], especially during extradural haematoma evacuation [49]. If the ophthalmic artery originates from the frontal branch of the middle meningeal artery [27, 48], pterional craniotomy could cause ophthalmic artery occlusion, which may end up in blindness [48]. Pterion is also used in various neurosurgical approaches treating anterior and middle skull base lesions [33], such as anterior and posterior cerebral circulation lesions, middle cerebral artery or upper basilar complex aneurysms, optic nerve and sellar and parasellar area lesions, sphenoidal wing, cavernous sinus, orbit, anterior and medial temporal lobe, midbrain, and posterior-inferior frontal lobe tumours, as well as cerebral tumours [4, 12, 15, 17, 19, 52, 57–61].

Information obtained from the current study may be of significant value in preoperative planning and perioperative navigation. Furthermore, recognition of the possible variants in location, morphology and morphometry of the pterion, as well as EBs occurrence may render pterional craniotomy safer among different population groups.

CONCLUSIONS

All pteria types were found in the current study and SP pterion was the predominant one, while FT was the less frequently observed. Pterional symmetry existed in the majority of cases, while gender and age had no significant impact on pterion type. EBs were observed in 15.5% of the skulls, and in the majority of the cases were tri- and quatrisutural. The distances of the pterion from MPZ and FZMS were symmetrical and gender dimorphism was found only in pterion-FZMS distance on the L. Information obtained from the current study may be of significant value in preoperative planning and perioperative navigation. Such data are especially mandatory to achieve the optimum craniotomy when neuronavigation is not available. Based on osseous landmarks, the neurosurgeon should be familiar with the sutural junctions, as well as with EBs variants which may be complicate the orientation. Furthermore, recognition of possible variants in pterion location, morphology and morphometry, as well as possible EBs occurrence may render pterional craniotomy safer among different population groups.

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